Preferred Session: CBRNE focus on Transportation (IEDs)

Title: Monitoring/Verification using DMS: TATP Example

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Field-rugged and field-programmable differential mobility spectrometry (DMS) networks provide highly selective, universal monitoring of vapors and aerosols at detectable levels from persons or areas involved with illicit chemical/biological/explosives (CBE) production. CBE sensor motes used in conjunction with automated fast gas chromatography with DMS detection (GC/DMS) verification instrumentation integrated into situational operations management systems can be readily deployed and optimized for changing application scenarios. The feasibility of developing selective DMS motes for a "smart dust" sampling approach with guided, highly selective, fast GC/DMS verification analysis is a compelling approach to minimize or prevent the use of explosives or chemical and biological weapons in terrorist activities.

Two peroxide-based liquid explosives, triacetone triperoxide (TATP) and hexamethylene triperoxide diamine (HMTD), are synthesized from common chemicals such as hydrogen peroxide, acetone, sulfuric acid, ammonia, and citric acid (Figure 1). Recipes can be readily found on the Internet by anyone seeking to generate sufficient quantities of these highly explosive chemicals to cause considerable collateral damage. Detection of TATP and HMTD by advanced sensing systems can provide the early warning necessary to prevent terror plots from coming to fruition.

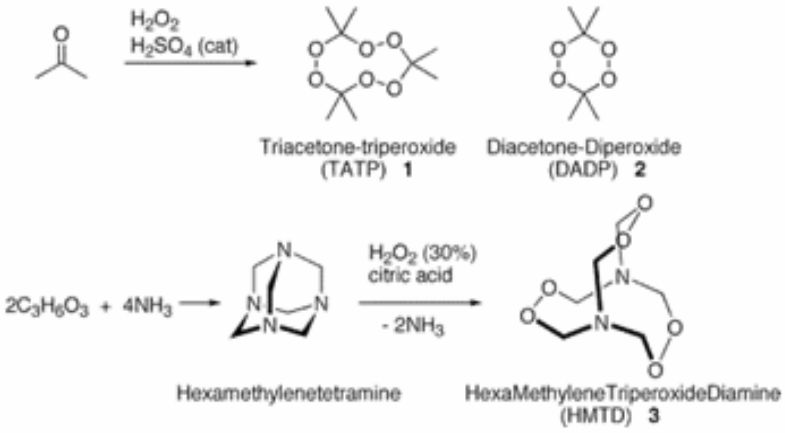

Figure 1. Synthesis scheme for TATP and HMTD.

DMS is currently one of the foremost emerging technologies for the separation and detection of gas-phase chemical species. This is due to trace-level detection limits, high selectivity, and small size. DMS separates and identifies ions at ambient pressures by utilizing the non-linear dependence of an ion's mobility on the radio frequency (rf) electric field strength.

GC is widely considered to be one of the leading analytical methods for the separation of chemical species in complex mixtures. Advances in the technique have led to the development

of low-thermal-mass fast GC columns. These columns are capable of completing runs in less than 3 minutes. Fast GC columns are also more compact than their traditional counterparts.

An earlier collaborative effort involving these authors optimized a handheld, fast GC/DMS, equipped with a non-rad ionization source, for the detection of TATP (Figure 2). The unit combines the separation capabilities of GC with the selectivity of DMS. Analytes are identified both by their elution time from the column and by the characteristic response in the DMS spectrum. Analysis times required to obtain results for these analytes are approximately 80 seconds for TATP and 160 seconds for HMTD (Figure 3).

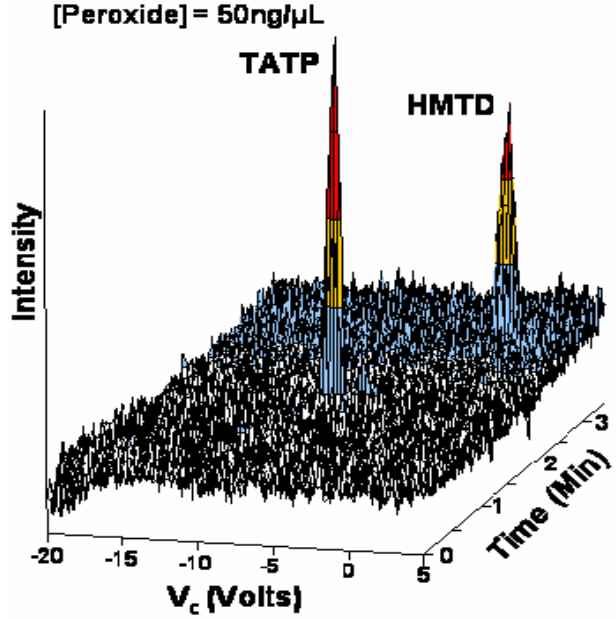

Figure 2. GC/DMS spectrum of TATP and HMTD

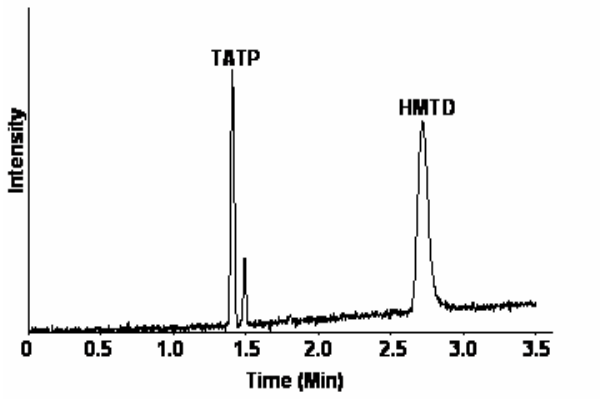

Figure 3. Chromatograms of TATP and HMTD

The limit of detection for both TATP and HMTD is approximately 1 ng/µL. Substances that could interfere with the detection of peroxide-based explosives have been studied. Both the GC elution time and the DMS spectral peak locations were unique and do not hinder the detection of either TATP or HMTD.

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